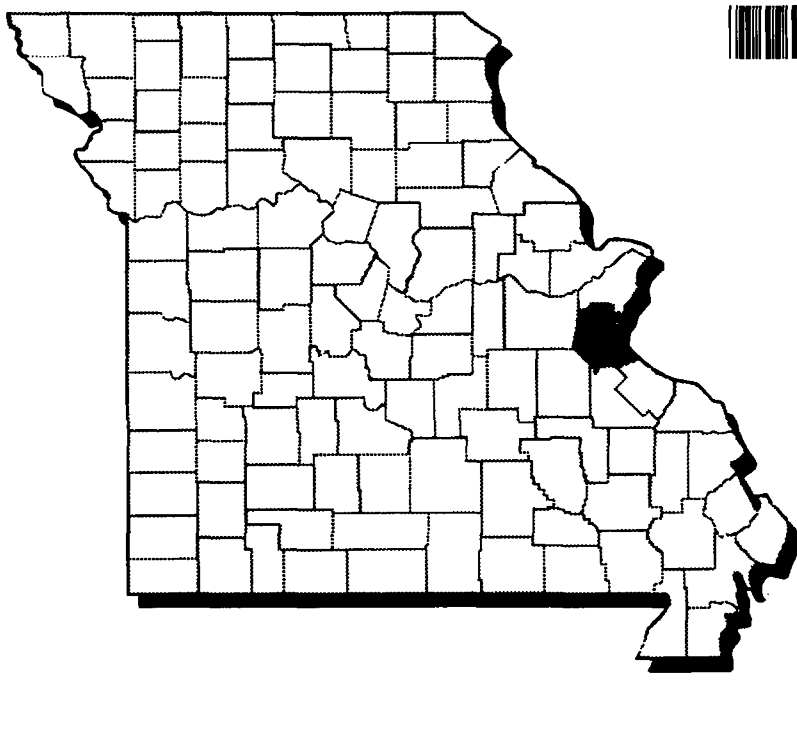
PRELIMINARY ASSESSMENT REPORT

Herculaneum Lead Smelter Site
Jefferson County, Missouri

March 30, 1999



Missouri Department of Natural Resources
Division of Environmental Quality
Hazardous Waste Program

TABLE OF CONTENTS

TABLE OF CONTENTS

DATE: March 30, 1999

PREPARED BY: Valerie H. Wilder
Missouri Department of Natural Resources

SITE: Herculaneum Lead Smelter
Jefferson County

C.A. NUMBER: V997381-98-0

EPA ID. NUMBER: MOD006266373

1.0 INTRODUCTION

Under the authority of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA), the Missouri Department of Natural Resources (DNR), through a cooperative agreement with the U.S. Environmental Protection Agency (EPA), conducted a Preliminary Assessment (PA) at the Herculaneum Lead Smelter site in Jefferson County, Missouri.

The Herculaneum Lead Smelter site is an active lead smelting facility, currently owned and operated by the Doe Run Company. The site was formerly known as the St. Joe Lead Co. and is listed in the Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) as the St. Joe Lead Co. site. A Preliminary Assessment was completed by EPA Region VII on September 25, 1980. A Site Inspection was completed by EPA on September 29, 1980. On February 2, 1981 a Final Strategy Determination was completed with a recommendation for no action needed based on a rationale that the "source material [slag] is not hazardous by law and that steps were being taken to correct water quality problems". The PA and SI conducted in 1980 were limited in nature. No samples were collected at the SI investigation in 1980. Current information regarding site conditions indicated the site warrants a new Preliminary Assessment investigation. Slag is defined as the vitreous mass left as a residue by the smelting of metallic ore. Slag material is not exempt from regulation under CERCLA law.

The purpose of this Preliminary Assessment investigation was to collect sufficient information concerning conditions at the site to assess the threat posed to human health and the environment, and to determine the need for additional investigation under CERCLA/SARA or other authority. The scope of the investigation included review of previous file information, collecting additional non-sampling information. The PA was initiated on July 15, 1998. Investigation included a site visit on February 25, 1999.

2.0 SITE DESCRIPTION

2.1 Location

The Herculaneum Lead Smelter site is located at 881 Main Street in Herculaneum, Missouri. The site is located about 25 miles south of St. Louis, on the Mississippi River (Reference 3). Geographic coordinates of the site as measured with a Garmin 12LX Global Positioning System from near the northwestern corner of the slag pile are 38°15'19.0" north latitude and 90°22'56.7" west longitude (Reference 4). The slag pile and most of the smelter facility are located in Jefferson County, Section 29, Township 41 North, Range 6 East, although the northern portion of the smelter facility extends into Section 20. Figure 1 in Appendix A is a site location map (Reference 3).

The site can be accessed from Interstate 55 in St. Louis by taking I-55 south to the Herculaneum exit, #178; turn left and head east on McNutt Street to Commercial Blvd., which is Highway 61/67. Turn left and head north on Commercial Blvd for 0.4 of a mile to Joachim Ave. There will be a sign to Doe Run at the intersection. Veer to the right onto Joachim Ave. Follow the signs for Doe Run - turn right onto Brown Street, which turns into Station Street as it curves sharply to the left. Station St. runs into Main Street at the Herculaneum Smelter (Reference 5).

The St. Louis area receives an average of 37.51 inches of precipitation annually, and an average of 22.2 inches of snowfall annually (Reference 6). The maximum expected two-year, 24-hour rainfall is approximately 2.5 inches (Reference 7, p. 14). The average daily temperature during the summer months is 77.6° F, and the average winter temperature is 32.4° F (Reference 6). The average wind speed and direction is approximately 12 miles per hour from the south (Reference 8, p. 2).

2.2 Site Description

The Herculaneum lead smelter, owned and operated by the Doe Run Company, is currently the largest lead smelter in the United States. The smelter has been in operation since 1892 (Reference 9). The site is approximately 52 acres in size, consisting of two main areas, the smelter plant located along the east side of Main Street from Station Street to Ferry Road (28 acres), and the slag storage pile located south-southwest of the plant in the floodplain of Joachim Creek (24 acres) (Reference 3). Figures 2 and 3 in Appendix A are site maps. Figure 3 is an aerial photograph of the site and surrounding area with features such as the slag storage area, monitoring wells, property lines, Joachim Creek and the Mississippi River marked on the map.

The smelting facility operations occupy approximately 28 acres which is bordered on the east by the Mississippi River and on the west by residential areas. The smelter's location facilitates rail, highway and river transportation. The smelting facility consists of office buildings on the west side of Main Street and all the process buildings on the east side. There is a main change house building for workers with lockers, shower facilities, laundry facilities and a cafeteria. The sinter, smelter and refining operation buildings take up the majority of the facility area. The smelter's wastewater treatment plant is also located in the main smelter facility area. The acid plant is located on the north end of the facility near Ferry Road. There are several storage tanks for the acid (Photo 21) and a barge loading dock on the Mississippi River for transporting the acid (Photo 22). Near the acid plant, there is a small pile of newer generation slag material that was apparently deposited there over 20 years ago. Railroad tracks border the facility's buildings on the east along the Mississippi River (Photo 21). The smelter facility is fenced with gates and signs (Reference 5).

On February 25, 1999 several DNR Land Reclamation Program personnel inspected the slag pile, referred to as the Metallic Minerals Waste Management Area. Hazardous Waste Program, Superfund personnel conducted a site visit on the same day. Photos 1 through 20 were taken of the slag pile area during the site visit. The road entrance to the northwest corner slag pile is located just south of Dale Street. It is blocked with a locked cable to prevent unauthorized vehicle access. Just recently, in early 1999, Doe Run constructed a drainage diversion ditch along the north side of the slag pile (Photos 1, 2). The ditch is approximately 15 – 20 feet deep; the sides of the ditch are lined with large rocks. The ditch is designed to divert any runoff from the area north of the slag pile. The access road to the slag pile runs around almost the entire slag pile. The slag pile itself is at least 40 to 50 feet high in some places (Photos 8, 9, 11, 12). Wildlife tracks, specifically deer tracks, can been seen in the slag material (Photos 5, 8). Railcars and trucks are used to transport slag material (Photos 7, 17). The majority of the visible slag in the pile is very fine material. It is referred to as newer generation slag material. Throughout the pile, though, are areas with larger pieces of slag material (Photo 13) (Reference 5).

The ground surface surrounding the toe of the slag pile, up to the Joachim Creek is floodplain soil with grassy vegetation, trees and shrubs (Photos 10, 11). Some of the areas between the slag pile and Joachim Creek are saturated with water, very marshy (Photos 15, 16). There are several groundwater monitoring wells that have been installed around the slag pile (Photo 16). Joachim Creek surrounds the slag storage pile on all sides. There is an average of about 200 to 350 feet between the toe of the slag pile on the west and south sides and bank of Joachim Creek (Photos 3, 6, 20). There is an old concrete railroad track bridge foundation that runs across Joachim Creek near the northwest corner of the slag pile (Photo 19) (Reference 5).

2.3 Operational History/Site Ownership

The Herculaneum Lead Smelter is the largest smelter of its kind in the United States. It began operations in 1892 as part of the St. Joseph Lead Company. In 1986, it became part of the newly formed Doe Run Company, a joint venture of the Fluor Corporation and The Homestake Mining Company. In 1990, Fluor became the sole owner of The Doe Run Company. Doe Run's headquarters is in St. Louis, Missouri (Reference 10).

The Doe Run Company owns and operates an integrated lead mining, milling, smelting, and refining company in eastern Missouri. Company operations presently include eight lead mines (in the Viburnum Trend), five mills, and three smelters. Lead ore, known as galena, is processed in the mills to form lead concentrate. The lead concentrate consists of approximately 80% lead sulfide (Reference 11).

The concentrate is shipped from the mines and mills to the Herculaneum smelter (or the Glover smelter). The Herculaneum facility operates 24-hours per day, 350 days per year. Currently, Doe Run has approximately 360 people on staff, and 70 - 90 contractors at the facility (References 11; 5). The following major process operations occur at the Herculaneum facility.

<u>Sintering Operations</u> (References 11; 9)
The Herculaneum facility receives approximately 7-8 shipments of lead ore concentrate per day by rail car with smaller amounts being received by truck. Upon arrival at the site the concentrate is dumped into a large feed hopper and mixed with fluxes and internally recycled lead-bearing materials such as baghouse fume. The main purpose of this mixing is to reduce the concentration of lead sulfide in the concentrate from approximately 80% to approximately 50%. It is also to form the proper sinter feed mix. The mixture is then tumbled to form pellets that are fed into the sinter machine. The sinter machine consists of a slowly moving grate that passes under a line of gas-fired burners.

The lead concentrate pellets are layered onto the sinter machine grate with the bottom layer of pellets ignited by the gas burners. The combustion zone is slowly moved from bottom to top by air pushed upward through the bed by large fans. The hot gaseous combustion products contain sulfur dioxide that has been removed from the concentrates. These gases are stripped of all entrained dust and other impurities in the baghouses and then converted to commercial grad sulfuric acid in the acid plant. After the cakes of sinter are discharged from the sinter machine, the sinter is crushed and screened to a suitable size for the blast furnaces.

<u>Smelting Operations</u> (Reference 9)
Lead-bearing sinter is the main ingredient in the feed for the blast furnace. Sinter is mixed with coke and continuously fed through the tops of the blast furnaces. As the feed descends into the shaft of the furnace, it passes through blasts of hot air and gases. Carbon contained in the coke reacts with the hot air forming chemically reducing gases, reducing the sinter to molten lead. Flowing from the bottom of the blast furnace, the molten lead collects in special pots and is immediately transferred to the drossing department. At the same time, molten slag composed of reduction by-products is tapped from the furnace, granulated and returned to the sinter department as feedstock.

Approximately 80% of the slag produced is actually reused as feedstock. The remaining 20% is sent to the slag storage pile when it is no longer of use as feedstock (Reference 5).

Once in the drossing department, the bullion from the blast furnaces is allowed to cool while impurities are removed by additional processing. Copper, nickel and other impurities begin to freeze from the solution, forming a layer at the surface called "dross". The dross is skimmed from the surface and separately melted and fluxed in a gas-fired "dross" furnace. The copper sulfide removed at this stage is a valuable by-product of lead smelting and is sold as a feedstock to copper smelters. Following final decopperizing, the lead is pumped to the refinery.

Refining Operations (Reference 11)
The refining process starts with the molten lead bullion being processed in the dross furnace. The bullion is then poured into one or more of 13 large kettles. Various metallurgical processes are used to remove zinc, copper, arsenides, and silver. Dross, skimmings of lighter metals and impurities, floats to the surface and is manually removed by a large crane operated dipper. Most of the dross is recycled through the sinter machine. A specialized vacuum condensation process is used on some of the kettles. The vacuum causes the remaining small quantities of zinc to condense out, thus providing a very high purity lead product. Silver and copper matte is removed during the refining process along with nickel "speiss". Speiss is a metallic arsenide and is not recycled. After the bullion has reached its specified level of purity, or has been alloyed to the proper specifications, it is pumped through heated casting lines to the casting areas. Two casting processes are used. Bullion may be form casted into 60 pound pigs, 1/2 and 1 ton ingots, or it may be continuously cast into sheets that are approximately one inch thick. These sheets are then processed through a rolling mill which reduces their thickness from one inch to approximately 0.025 inches. The 0.025", sheet is then cut into strips and then wound into coils.

Sulfuric Acid Production (Reference 11)
Doe Run-Herculaneum produces sulfuric acid from the waste sulfur containing gases produced by the sintering operation. These gases are routed via ductwork and fans to the acid plant. The gases are converted into sulfuric acid through the use of a Monsanto acid plant. This plant was installed in 1970 and produces approximately 50-60,000 tons of sulfuric acid per year. The acid is stored in on-site tanks until it can be loaded onto trucks, rail-cars, or barges for off-site transport. According to Doe Run, the manufacturing of sulfuric acid actually represents a net loss to the company. The primary purpose of the acid plant is to process the sulfur containing air pollutants into a manageable form.

Water
The Herculaneum smelter uses about 500,000 gallons of water a day in its processes. The smelter has its own wastewater treatment facility on-site (Reference 12). Sanitary

wastewater from the facility goes to the City of Herculaneum wastewater treatment, which is located south of the smelter facility and east of the slag pile. Manufacturing process water, rinse and wash water from workers clothes, and stormwater runoff from the paved areas of the facility are all treated through Doe Run's wastewater treatment facility (References 13). The discharge to the Mississippi River from the wastewater treatment facility is permitted under the Clean Water Act through a National Pollutant Discharge Elimination System (NPDES) Permit (MO-0000281) that is issued and monitored by the DNR's Water Pollution Control Program (WPCP). Limits are set in the permit for the amount of metals that can be discharged from the wastewater treatment faciltiy to the Mississippi River (Reference 14). More details regarding the NPDES permit are discussed in Section 5.4, Surface Water Conclusions.

2.4 Waste Characteristics

The Doe Run Herculaneum Smelter facility is classified as a large quantity generator. According to the Generator's Hazardous Waste Summary Report for the 2nd Quarter 1998 the following hazardous wastes were generated by the facility: D001 (ignitable), D006 (cadmium), D008 (lead), D018 (benzene), D039 (tetrachlorothylene), D040 (trichloroethylene), D027 (1,4-dichlorobenzene) (Reference 15).

EPA requires annual reports of toxic chemical releases to the environment under Section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA). These reports are submitted on the Toxic Release Inventory (TRI) Reporting Form. The reports are required to provide the public with information on the releases of listed toxic chemicals in their communities and to provide EPA with release information to assist the Agency in determining the need for future regulations. Facilities must report the quantities of both routine and accidental releases of listed toxic chemicals, as well as the maximum amount of the listed toxic chemical on-site during the calendar year and the amount in wastes transferred off-site (Reference 16).

The releases reported on the TRI are broken down by chemical and media released to (air, water, and land). In 1987, Doe Run's releases included (in order of total amount in pounds): zinc compounds (29,167,900), lead (8,208,068), copper (1,491,396), cadmium compounds (81,877), and sufuric acid (250). This is a total of 38,949,491 pounds. Over the years, process technology at the smelter has improved and the toxic releases have declined significantly since 1987. In 1996 the on-site releases included: zinc compounds (6,136,006), lead compounds (1,465,366), copper compounds (23,635), chromium compounds (24,658), cadmium compounds (14,587), nickel compounds (7,452), arsenic compounds (7,265), antimony compounds (699), cobalt compounds (385), and sulfuric acid (260). This is a total of 7,880,313 pounds – an 80% decrease since 1987 (Reference 17).

For six years out of eight, from 1988 to 1996, Doe Run's Herculaneum Smelter was the largest emitter in Missouri, according to the TRI. In 1992 and 1996, ASARCO's lead smelter (now owned by Doe Run) was the largest emitter (Reference 18).

The primary contaminants of concern regarding the slag pile are the heavy metals arsenic, cadmium, copper, lead, nickel, and zinc. Doe Run reports the slag material contains approximately 12-14% zinc and 1.5 - 2.5% lead, among other constituents. Analytical results from a sample of slag material collected from Doe Run's slag pile by the U.S. Fish & Wildlife Service documented the following metals: total arsenic – 28 ppm, total cadmium – 32 ppm, total copper – 3,200 ppm, total lead 23,000 ppm, total nickel – 140 ppm, and total zinc - 96,000 ppm (Reference 19, Appendix A – I).

Cadmium is a bluish-white metal that occurs naturally in the earth's crust. Cadmium is not usually found in the environment as a metal. It is usually found as a mineral combined with other elements such as oxygen, chlorine, or sulfur. Small amounts of cadmium are found in zinc, copper, and lead ores. It is generally produced as a by-product of these metals, particularly zinc. Cadmium is highly corrosion resistant and is used as a protective coating for iron, steel and copper. Cadmium can enter the environment in several ways. It can be found on small particles in the air and can enter the soil and water from spills. Cadmium is insoluble in water but is soluble in acids. Cadmium does not break down in the environment but can change into different forms. Most cadmium stays where it enters the environment for a long time. Some of the cadmium that enters the water will bind to soil but some will remain in the water.

Human exposure to cadmium occurs through inhalation and ingestion. The harmful effects of cadmium depend on the amount taken in and whether eaten or breathed. Breathing air with high levels of cadmium severely damages the lungs and can cause death. Breathing lower levels of cadmium for years leads to a build up of cadmium in the kidneys that can cause kidney disease. Eating food or drinking water with very high cadmium levels severely irritates the stomach, leading to vomiting and diarrhea, and sometimes death. Eating low levels of cadmium over a long period of time lead to a build-up of cadmium in the kidneys. The International Agency for Research on Cancer has determined that cadmium is carcinogenic to humans. The EPA has determined that cadmium is a probable human carcinogen by inhalation. Cadmium is classified as a hazardous waste constituent and priority toxic pollutant by EPA (References 20, pp. 1-6; 21, p. 169).

Lead is a naturally occurring bluish-gray metal found in small amounts in the earth's crust. Lead usually adsorbs to soil particles. Small amounts of lead may enter water bodies when soil particles are displaced by rainwater. Lead may absorb to soil particles in water for many years. Movement of lead from soil particles into underground water or drinking water is unlikely unless the water is acidic or soft. Most lead absorbed by plants or consumed by animals passes through their bodies; however, the small amount absorbed can cause harmful effects. Lead is classified as a hazardous substance (certain compounds), hazardous waste constituent, and priority toxic pollutant by EPA (References 22, pp. 1-7; 21, p. 542).

The effects of lead are the same whether it enters the body through breathing or swallowing. In adults, lead exposure may decrease reaction time and possibly affect memory. Lead exposure may also cause anemia, a disorder of the blood. Exposure to lead can be particularly dangerous for unborn children and young children because of their great sensitivity during development. Unborn children can be exposed to lead through their mothers. This may cause premature births, smaller babies, and decreased mental ability in the infant. Exposure to lead can also be dangerous for young children because they swallow more lead through the normal activity of putting things that could contain lead into their mouths. Compared to adults, children absorb more of the lead that they swallow into their bodies, retain more of the lead they take in, and are more sensitive to its effects. Lead exposure may also decrease intelligence quotient scores and reduce the growth of young children (Reference 22, pp. 7, 8).

Zinc is one of the most common elements in the earth's crust. In its pure elemental (or metallic) form, zinc is a bluish-white shiny metal. Most zinc enters the environment as the result of human activities, such as mining, purifying of zinc, lead and cadmium ores, steel production, coal burning, and burning of wastes. Waste streams from zinc and other metal manufacturing and zinc chemical industries, domestic waste water, and run-off from soil containing zinc can discharge zinc into waterways (Reference 23, pp. 1-3).

Most of the zinc in bodies of water, such as lakes or rivers, settles on the bottom. However, a small amount may remain either dissolved in water or as fine suspended particles. The level of dissolved zinc in water may increase as the acidity of water increases. Some fish can collect zinc in their bodies if they live in water containing zinc. Most of the zinc in soil is bound to the soil and does not dissolve in water. However, depending on the characteristics of the soil, some zinc may reach groundwater. Zinc may be taken up by animals eating soil or drinking water containing zinc. If other animals eat these animals, they will have increased amounts of zinc in their bodies (Reference 23, p. 3).

Inhaling large amounts of zinc (as zinc dust or fumes from smelting or welding) can cause a specific short-term disease called metal fume fever. However, very little is known about the long-term effects of breathing zinc dust or fumes (Reference 23, p. 5).

3.0 WASTES/SOURCES

The slag material generated at the Herculaneum smelter is disposed of in a Metallic Minerals Waste Management Area (WMA) that was permitted in 1992 under the Metallic Minerals Waste Management Act (effective April 29, 1991). According to the permit, the proposed WMA will, upon closure, occupy a total area of approximately 62 acres: the currently active slag pile is allotted 40 acres in the floodplain of Joachim Creek (S ½

Section 29, T41N, R6E) (currently about 24 acres have been used), and the future slag pile is allotted 22 acres in an area across Joachim Creek (NW ¼ Section 29, T41N, R6E). As stated in the permit, the WMA is projected to remain in operation until the year 2031 (Reference 24).

As required by the Metallic Minerals Waste Management Act, the Herculaneum permit for the WMA includes information regarding the legal descriptions, operating life, closure plan, inspection-maintenance plan, and measures to protect surface water and groundwater. In the permit, the proposed final designated use of the WMA is as a wildlife area. The pile will be graded, covered with soil and revegetated. The groundwater protection plan outlined in the permit includes a current monitoring program that is discussed in more detail in Section 4.3 Groundwater Sampling Data. Protection of surface water is briefly covered in the permit to the extent that it is stated that there is no point source discharge from the WMA, so there is no NPDES permit specifically for the WMA. This information is out of date. There is in fact, point source discharge from the WMA, and an application for an NPDES permit to Joachim Creek is currently under review at DNR (Reference 24).

Information in Doe Run Herculaneum's Metallic Minerals Waste Management Act permit was scheduled to be reviewed and updated by DNR's Land Reclamation Program (LRP) five years after it was issued. The five year review will actually be completed sometime in 1999 or 2000.

As an alternative to closing the slag pile in place at the Waste Management Area, Doe Run has been researching a process known as slag fuming. The process would extract the leftover zinc in the slag. Based on tests conducted during 1995, Doe Run's Chief Metallurgist reports that slag fuming is economically feasible based on pilot testing (Reference 25).

4.0 GROUNDWATER PATHWAY

4.1 Hydrogeologic Setting (Reference 26)

Stratigraphic Units

A stratigraphic column (Table 1 on page 14) has been tabulated based upon the stratigraphy of nearby wells. At least 14 monitoring wells have been installed at the facility. Information on the monitoring wells is presented in the "Metallic Minerals Waste Management Permit Application for the Herculaneum Facility Slag Disposal Area". Joachim Creek alluvium in the vicinity of the site is approximately 20 to 45 feet thick.. Mississippi River valley alluvium in the vicinity of the site may be as thick at 291 feet.

Bedrock in the area has been structurally deformed by folding and faulting. The youngest bedrock formation beneath the slag pile is the Ordovician-age St. Peter Sandstone, assigned to the Champlain Series. The St. Peter Sandstone is an important source of groundwater in the area, particularly in domestic wells. Younger bedrock formations are present under the northern part of the smelter facility.

Stratigraphically above the St. Peter Sandstone, carbonates of the Plattin and Joachim Formations form the uppermost strata of the Ozark aquifer. These carbonates vary considerably in water bearing characteristics, and typically produce low yields in the Herculaneum area. Beneath the St. Peter Sandstone, the Everton Formation can produce only moderate amounts of water and is not an important source of groundwater.

Beneath the Everton Formation, thick Canadian-age dolostones are encountered. The uppermost dolostones are approximately 500 feet thick and have been divided into three units. From youngest to oldest, they are: the Powell Dolomite, the Cotter Dolomite, and the Jefferson City Dolomite. These formations are difficult to differentiate. Some geologists consider the Powell Dolomite to be an upper-Cotter Dolomite strata. The Jefferson City and Cotter Dolomites are often designated as the "Jefferson City-Cotter Dolomite". The Jefferson City-Cotter Dolomite is composed principally of medium- to finely-crystalline dolomite and argillaceous dolomite with minor lenses of sandstone and shale.

Underlying the dolostones, the Roubidoux Formation consists of dolomite, sandy dolomite, and sandstone. This formation is approximately 130 feet thick in the vicinity of the site. The Gasconade Dolomite, which is present below the Roubidoux Formation, consists of cherty dolomite and is estimated to be approximately 170 feet thick in the vicinity of the site. A basal unit of the Gasconade Dolomite, known as the Gunter Sandstone Member, commonly separates the Ordovician- and Cambrian-age strata. The Gunter Sandstone is approximately 30 feet thick in the Herculaneum area.

The upper-most Cambrian unit in the area is the Eminence Dolomite, which consists of approximately 300 feet of dolomite with minor amounts of chert. The Eminence Dolomite is underlain by about 220 feet of Potosi Dolomite, which consists of dolomite, chert, and drusy quartz. Beneath the Potosi Dolomite, in descending order, are the Derby-Doerun Dolomite, the Davis Formation, the Bonneterre Formation, and the Lamotte Sandstone. The entire Cambrian section is estimated to be over 2,000 feet thick.

<u>Aquifers</u>
Groundwater is encountered at shallow depths in the unconsolidated material beneath the slag pile. The Joachim Creek alluvium is not used as a groundwater source in the Herculaneum area because better-quality water is generally available in the bedrock aquifers. Most of the alluvial groundwater is mineralized and contains iron and manganese. However, downstream of Herculaneum, the Mississippi River alluvial aquifer is used as a water supply for Crystal City. The Mississippi River is a regional

zone of groundwater discharge, and groundwater in the alluvium is not expected to extensively recharge the bedrock aquifers.

The Ozark Aquifer, which includes all bedrock units above the Cambrian-age Derby-Doerun Dolomite, is the shallowest aquifer beneath site. The Ozark Aquifer is expected to be encountered approximately 40 feet below the surface. The total thickness of the aquifer in the vicinity of the site is approximately 1,700 feet. Each of the units which comprise the Ozark Aquifer have individual characteristics that control their water-bearing capabilities; however, in general, the Ozark Aquifer produces good-quality water, with production rates generally proportional to well depth. Nearby shallow domestic wells completed in the upper part of the Ozark aquifer are not expected to be threatened by potential contaminant releases to groundwater because an upward gradient generally exists in the bedrock aquifers adjacent to the Mississippi River. However, extensive pumping of the Herculaneum municipal well system could cause conditions at the site to change so that the bedrock aquifer becomes a recharge zone.

Because detailed hydrogeologic studies have not been conducted in the vicinity of the site, groundwater flow directions within the bedrock can only be approximated. The Mississippi River, which flows adjacent to the site, is expected to be a major regional groundwater discharge area. Groundwater in the bedrock should flow toward the Mississippi River or toward municipal pumping wells.

Pumping rates at the Herculaneum municipal wells which draw water from the Ozark aquifer, may be high enough to engulf the site within the cones of depression that surround the municipal wells. The radius of influence of nearby production wells should be determined. Pumping data for the Herculaneum wells should be obtained and compared to water level information from on-site deep monitoring well #8 to see if there is a hydraulic connection. If groundwater pumping is causing a downward gradient beneath the site, escaping contaminants may reach the water supply as there is no reliable aquitard to protect the Ozark aquifer. Faulting in the vicinity of the site may have resulted in local increases in permeability, facilitating rapid movement of any contaminants.

The Roubidoux Formation is generally highly porous and is an important source of municipal water supply in the Herculaneum area. The Eminence and Potosi Dolomites are a major source of municipal drinking water throughout the Ozark area, but are not extensively used in the Herculaneum area because of their great depth. Herculaneum Well No. 3, located approximately 1/3 mile north of the slag pile site, penetrated the Roubidoux but was plugged back to 750 feet because the Roubidoux contained saline water. Herculaneum Well No. 3 thus produces from the Jefferson City Dolomite and younger formations. The Herculaneum area is near the irregular interface that separates potable groundwater from groundwater that contains concentrations of constituents that exceed desirable drinking water standards. Bedrock aquifers north and east of the Herculaneum area generally contain poor quality groundwater.

The shallowest reliable aquitard beneath the site is the St. Francois Confining Unit, approximately 1,200 feet below the surface. The St. Francois Confining Unit separates the Ozark Aquifer from the deeper St. Francois Aquifer. Groundwater flow in the deeper St. Francois Aquifer may be complicated. The St. Francois Aquifer is not used as a water source in northeast Jefferson County.

Aquifer Discontinuities
Folding and faulting associated with the Eureka-House Springs structure is present within the four-mile groundwater target distance limit, but the structures affect on groundwater movement is poorly understood. Joachim Creek is a gaining stream, and it is considered unlikely that any contaminants escaping into the subsurface could cause problems south of the creek.

The slag pile is located less than 1/3 mile west of the Mississippi River, a major zone of regional groundwater discharge; consequently, the bedrock aquifers are expected to exhibit upward vertical gradients. However, deep monitoring well #8 installed south of the slag pile displays a downward gradient. Groundwater apparently moves out of the Joachim Creek alluvium and down into the St, Peter Sandstone. This downward gradient may be caused by municipal well pumpage. However, it is also possible that any recharge to the water table would quickly reach the alluvium of the Mississippi River and not affect the bedrock aquifers. The downward gradient seen at the site may reflect rapid discharge of groundwater in the St. Peter Sandstone into thick Mississippi River alluvium. The Mississippi River trench may be particularly deep in the Herculaneum area due to structural deformation or intense scouring by meltwaters from the last Wisconsin continental glacier.

The Mississippi River serves as a regional groundwater discharge area and, consequently, as an aquifer discontinuity within the four-mile groundwater target distance limit.

Wellhead Protection Area
Herculaneum is located in Area 1, as designated by the DGLS Wellhead Protection Section. Since September 1987, Area 1 bedrock wells have been required to have 80 feet of casing and penetrate at least 30 feet of bedrock.

Karst Features
The Herculaneum area is not considered karst. Northern Jefferson County is considered karst, but the Herculaneum area is approximately five miles south of the karst area and significant karst features are not present within a four-mile radius of the site. The Ordovician-age sediments that underlie the site generally lack solution features in this part of the state.

<u>Geologic Structures</u>
Approximately one-half mile north of the slag pile, a northwest-trending fault cuts the smelter property. The fault offsets bedrock approximately 100 feet, with strata to the north downdropped. The fault is related to the Eureka-House Springs Structure, which also trends northwest. The Eureka-House Springs structure has been described as "part of an anticlinal structure that extends from Riverside in Jefferson County on the Mississippi River through the House Springs-Eureka area northwest across the Missouri River to north of New Melle". Recent studies have separated the feature into an anticline (the Eureka-House Springs structure) and parallel faults (the Eureka-House Springs fault system). The fault system may be several thousand feet wide. Bedrock formations in the Herculaneum area dip toward the north at approximately 75-100 feet per mile.

Published maps show major fault structures within the four miles of the site. Well log information suggests that more faults may affect the Herculaneum Smelter area. The effects of the structural deformation on groundwater are poorly understood, but the faulting and folding has almost certainly increased hydraulic conductivities in some areas. Groundwater may flow along conduits within the structures.

4.2 **Groundwater Targets** (Reference 26)

Groundwater use within four miles of the site is extensive. Most businesses and residences in the vicinity of the Herculaneum Smelter site are on city water.

Over 200 well locations within the groundwater target distance limit are recorded in the databases available at DNR's Division of Geology and Land Survey. The LOGMAIN (WLP) database contains information on older wells. The DGLS Well Wellhead Protection Section's Water Well Information System (W.I.M.S.) database contains information on wells drilled since 1987. Six additional wells are recorded in DNR's Public Drinking Water Program database. These six wells are not recorded in either DGLS database.

Well site locations are presented in Reference 26-Figure 4, and the corresponding well data is tabulated in Reference 26-Table 2. Some locations may be estimated or based on section centroids. The majority of the wells on record are domestic supply wells. The databases contain some errors and information should be verified when possible.

The nearest private drinking water well on record is located approximately 1/3 mile southwest of the Herculaneum Smelter slag pile (Reference 26-Figure 4, DGLS Logmain #006714). The well was drilled in 1940 and its current status is unknown. The well is on the opposite side of Joachim Creek, a gaining stream, and the well is not likely to be affected by smelter activities.

TABLE 1: STRATIGRAPHIC COLUMN FOR HERCULANEUM SMELTER (after Miller, 1974)

System	Aquifer Group	Approx. Site Spec. Thick-ness (ft)	Formation	Hydraulic Conductivity (cm/sec)	Regional Thickness (ft)	Dominant Lithology	Water-bearing Character
Quaternary	Alluvial	20?	Alluvium	10^{-4}	0-60	Clay, silt, sand and gravel	Some wells yield large quantities of potable water.
Ordovician	Ozark Aquifer	130	Decorah Formation	10^{-6}	0-50	Limestone, dolomitic limestone and shale	May act as a confining bed.
		115	Plattin Limestone	10^{-5}	0-200	Finely crystalline limestone	Yields small quantities of water to wells. Yields up to 40 gpm
		140	Joachim Dolomite	10^{-5}	0-145	Argillaceous dolomite	Yields small quantities of water to wells. Yields up to 40 gpm
		40	St. Peter Sandstone	10^{-3}	40-60	Quartzose sandstone	Yields moderate quantities of water to wells. Yields up to 150 gpm
		65	Everton Formation	10^{-4}	0-280	Dolostone and sandstone	Yields small quantities of water to wells.
		90	Powell Dolomite	10^{-5}	0-320	Cherty dolomites and minor sandstone	Yields small to moderate quantities of water to wells. Yields range from 10 to 100 gpm. Some less-permeable sections may act as leaky confining units.
		200	Cotter Dolomite		0-225		
		200	Jefferson City Dolomite		0-177		
		130	Roubidoux Formation	10^{-3}	0-280	Sandstone and sandy dolomite	Yields large quantities of water to wells. Yields up to 400 gpm
		170	Gasconade Dolomite	10^{-6}	0-325	Cherty dolomite, minor siltstones, sandstone, and shale	Yields moderate to large quantities of water to wells. Yields range from 100 to 400 gpm. Less-permeable Upper Gasconade may act as a leaky confining unit.
		30	Gunter Sandstone Member	10^{-4}	0-30	Sandstone	Contributes moderate to large quantities of water. Most wells open to other formations
Cambrian		515	Eminence and Potosi Dolomites	10^{-5}	0-600	Cherty dolomite	Yields moderate to large quantities of water to wells. Yields range from 100 to 400 gpm.
	St. Francois Confining Unit	100	Derby-Doerun Dolomite	10^{-7}	0-165	Shaley dolomites and shale	Reliable aquitard
		120	Davis Formation	10^{-7}	0-150		
	St. Francois Aquifer	380	Bonneterre Formation	10^{-5}	100-385	Dolomite and sands	Generally used only in outcrop areas
		400	Lamotte Sandstone	10^{-5}	135+	Sandstone	
Precambrian	Basement Confining Unit					Igneous and metamorphic rocks	Does not yield water to wells in this area

The nearest public drinking water supply well on record is the City of Herculaneum well #3, located about 1/3 mile north of the Herculaneum Smelter site slag pile (Reference 26-Figure 4, DGLS Logmain #022579). The well was drilled in 1930 and has 380 feet of casing. The City of Herculaneum has four other wells within four miles of the Herculaneum Lead Smelter site. The well numbering system for the City of Herculaneum wells is not consistent among the databases examined for this report. Total production from the five wells was 166,700,000 gallons in 1996. Other nearby cities also have public drinking water wells within four miles of the site.

A total of 12 wells are located within 1 mile of the site. An additional 26 wells are located between 1 and 2 miles from the site, 45 wells are located between 2 and 3 miles from the site, and 119 wells are located between 3 and 4 miles of the site.

Except for the Crystal City Ranney well drilled into the Mississippi River alluvium, all wells draw water from the Ozark Aquifer.

4.3 Groundwater Sampling Data (Reference 27)

Groundwater quality has been monitored at the site of the slag storage area since July 1980. The monitoring well network consisted of 14 wells installed during two phases. Figure 3 in Appendix A shows the location of all wells on a aerial photograph site map. Wells number 1 through 7 were installed in April 1980. The second group of wells was installed in 1984. Wells 4B and 14B were installed in January 1994 as replacements for the damaged wells 4 and 14.

Monitoring of the network was attempted on a monthly basis from July 1980 through October 1983. In 1984, the monitoring program changed focus to a quarterly sampling basis. During the first five years of the monitoring program, July 1980 through November 1985, Doe Run was responsible for the sample collection and analysis. After this period, Maxim Technologies, Inc., located in St. Louis, was contracted on an as-needed basis to collect samples. The Doe Run's laboratory had been responsible for laboratory analysis of all samples until August 1987. Since then, Maxim laboratory has been responsible for sample analysis.

The current monitoring well network consists of nine wells, numbered 3, 4B, 7, 8, 9, 10, 12, 13 and 14B. Well 13 was previously determined to be the upgradient well under all seasonal conditions and results of analysis on this well are used as the background standard.

The wells were monitored quarterly during the past 10 year period for lead, nickel, and zinc. Also, as recommended, the wells were monitored on an annual basis (first quarter of each year) for all the metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver). Electric conductivity and pH values were monitored quarterly as indicator parameters.

Data collected from the nine wells over the past thirty quarters were used to perform statistical analyses using the methods described in "Statistical Analysis of Groundwater Monitoring Data and RCRA Facilities". Only the metals lead, nickel and zinc were statistically evaluated. Statistical results of the test of proportions for dissolved lead and nickel showed that there was no statistically significant evidence that dissolved lead or nickel has impacted the downgradient wells. Statistical results did, however, show that dissolved zinc had impacted the downgradient wells 4 and 7. The highest documented concentration of zinc as 484 ppb (August 31, 1992). None of the levels of the dissolved zinc in the groundwater exceeded the EPA Removal Action Level for drinking water (3,000 ppb) or the SCDM Reference Dose Screening Concentration (11,000 ppb). There is no EPA MCL for zinc.

Tables 2 and 3 on pages 17 and 18 presents the lead and cadmium analytical results for all the monitoring wells over the ten year period starting in 1987. Reference 27 contains all monitoring data in the Final Herculaneum Slag Storage Area Groundwater Monitoring Program Report.

4.4 Conclusions

According to a statistical analysis of groundwater montoring data, performed for the Final Herculaneum Slag Storage Area Groundwater Monitoring Program Report, zinc was the only metal of the three analyzed statistically (lead, nickel, zinc), that has been released from the slag pile into the shallow groundwater above background concentrations. The highest documented concentration of zinc was 484 ppb (August 31, 1992); background concentration was less than 6 ppb. None of the levels of the dissolved zinc in the groundwater exceeded the EPA Removal Action Level for drinking water (3,000 ppb) or the SCDM Reference Dose Screening Concentration (11,000 ppb). There is no EPA MCL for zinc.

The Joachim Creek alluvium is not used as a groundwater source in the Herculaneum area. In addition, the Mississippi River is a regional zone of groundwater discharge, and groundwater in the alluvium is not expected to extensively recharge the bedrock aquifers. Nearby shallow domestic wells completed in the upper part of the Ozark aquifer are not expected to be threatened by potential contaminant releases to groundwater because an upward gradient generally exists in the bedrock aquifers adjacent to the Mississippi River.

Pumping rates at the Herculaneum municipal wells which draw water from the Ozark aquifer, may be high enough to engulf the site within the cones of depression that surround the municipal wells. The radius of influence of nearby production wells should be determined. Pumping data for the Herculaneum wells should be obtained and compared to water level information from on-site deep monitoring well #8 to see if there is a hydraulic connection. If groundwater pumping is causing a downward gradient beneath the site, escaping contaminants may reach the water supply as there is no reliable aquitard to protect the Ozark aquifer. Faulting in the vicinity of the site may have resulted in local increases in permeability, facilitating rapid movement of any contaminants.

TABLE 2: DOE RUN HERCULANEUM QUARTERLY MONITORING RESULTS FOR LEAD
All results in parts per billion (ppb)

MCL for Lead = 15 ppb Bolded results are those above the MCL

Date of Sampling	MW 13 bkgrnd	MW 3	MW 4	MW 4B	MW 7	MW 8	MW 9	MW 10	MW 12	MW 14	MW 14B
9/3/87	< 20	< 20	< 20		< 20	< 20	< 20	< 20	< 20	< 20	
12/30/87 & 1/11/88	< 5	< 5	< 5		< 5	< 5	< 5	< 5	< 5	< 5	
3/30/88	9	12	**17**		**20**	15	**16**	10	14	15	
6/29/88	< 6	6	< 6		10	< 6	15	< 6	< 6	11	
9/29/88	< 3	< 5	< 3		< 3	< 3	< 3	< 3	< 3	< 3	
12/29/88	< 6	< 6	10		< 6	8	< 6	7	7	10	
3/27/89	4	< 3	10		6	< 3	6	9	4	17	
6/27/89	< 1	5	10		6	6	5	5	3	9	
9/26/89	5	7.5	< 1		< 1	< 1	< 1	< 1	3	1.5	
12/20/89	< 2	2	< 2		< 2	8.8	11.8	< 2	< 2	< 2	
3/27/90	2.5	7.1	2.0		1.7	3.8	5.3	2.5	4.4	6.3	
8/23/90	< 1	< 1	< 1		< 1	< 1	< 1	3.8	1.3	< 1	
11/21/91	< 1	1.8	–		1.9	2.1	1.6	3.0	1.2	< 1	
2/21/92	< 2	< 2	–		< 2	< 2	< 2	2	< 2	< 2	
5/28/92	**29.3**	**20.8**	**43.1**		**39.3**	**16.7**	**35.9**	**60.9**	**34.2**	–	
8/31/92	< 2	< 2	< 2		2	2.73	2.66	3.38	< 2	–	
2/4/93 & 2/8/93	< 1	< 1	< 1		< 1	5.7	< 1	< 1	< 1		
11/23/93	< 1	–	–		< 1	–	–	–	< 1		
12/30/93	< 12	< 12	< 12		19	30	< 12	–	< 12		
6/1/94	< 1	< 1		< 1	1.8	1.0	< 1	< 1	< 1		< 1
9/9/94	< 1.7	3.7		< 1.7	< 1.7	< 1.7	< 1.7	2.1	2.2		< 1.7
12/9/94	< 2.8	< 2.8		< 2.8	< 2.8	< 2.8	< 2.8	< 2.8	< 2.8		< 2.8
3/16/95	< 2.8	< 2.8		5.4	–	< 2.8	< 2,8	< 2.8	< 2.8		< 2.8
10/12/95	< 1	4.36		1.58	< 1	< 1	< 1	< 1	< 1		< 1
1/31/96	2.9	–		5.3	6.4	< 2	–	5.3	< 2		3.3
8/23/96	< 2	4.3		4.2	< 2	< 2	< 2	< 2	< 2		2.7
2/11/97	< 1	1.1		1.87	3.29	< 1	< 1	< 1	< 1		< 1
7/11/97 & 7/14/97	< 1	< 1		< 1	2.8	4.57	< 1	< 1	< 1		< 1
10/15/97	< 1	< 1		2.85	< 1	< 1	< 1	< 1	< 1		< 1
1/22/98	< 1	< 1		< 1	1.1	2.6	< 1	< 1	1.0		< 1

TABLE 3: DOE RUN HERCULANEUM QUARTERLY MONITORING RESULTS FOR CADMIUM All results in parts per billion (ppb)											
Cadmium was only sampled for annually, not quarterly MCL for Cadmium = 5 ppb Bolded results are those above the MCL											
Date of Sampling	MW 13 bkgrnd	MW 3	MW 4	MW 4B	MW 7	MW 8	MW 9	MW 10	MW 12	MW 14	MW 14B
9/3/87	< 5	< 5	< 5		< 5	< 5	< 5	< 5	< 5	< 5	
9/29/88	2	2	3		2	< 2	2	< 2	2	3	
9/26/89	1	< 1	1.6		< 1	< 1	< 1	2.5	**169**	< 1	
11/21/91	< 5	< 5	--		< 5	< 5	< 5	< 5	< 5	< 5	
2/4/93 & 2/8/93	**21**	8	< 5		< 5	< 5	**10**	7	**15**		
6/1/94	**18**	< 2		**13**	**9**	--	**12**	**9**	**10**		**10**
10/12/95	**16**	**6**		< 4	< 4	< 4	**9**	< 4	**8**		< 4
2/11/97	< 2	< 2		< 2	< 2	< 2	< 2	< 2	< 2		< 2

5.0 SURFACE WATER PATHWAY

5.1 Hydrologic Setting

The Herculaneum Smelter site is situated on a terrace, approximately 20 feet above the normal water level of the Joachim Creek. The site exhibits gentle natural relief (0% to 4% slopes). An entrenched meander of Joachim Creek surrounds the slag pile west, south and east of the site. The natural landform and drainage patterns at the site have been obscured by industrial activity. Land use patterns for the upland areas and the alluvial plain near the Herculaneum Smelter site include undeveloped land and light-industrial, commercial, and residential properties (Reference 26).

The Herculaneum Smelter site is located on very gentling sloping terrain; water runs onto the smelter facility from urban areas to the west. Runoff from the smelter facility is processed through the Doe Run's wastewater treatment facility on-site, discussed previously in Section 2.3, Operational History – Water. The treatment facility discharges to the Mississippi River under a Clean Water Act NPDES permit (MO0000281).

Until recently surface runoff water would flow onto the slag pile area from the north. In early 1999 Doe Run constructed a drainage diversion ditch along the north side of the slag pile (Photos 1, 2). The ditch is approximately 15 – 20 feet deep; the sides of the ditch are lined with large rocks. The ditch is designed to divert any runoff from the area north of the slag pile (Reference 5). Runoff in the ditch would eventually reach Joachim Creek. Precipitation falling directly onto the slag pile will also eventually reach nearby Joachim Creek. In July 1998, Doe Run submitted an application to DNR's WPCP for an additional storm water permit for discharges from the slag pile into Joachim Creek. That application is currently under review (Reference 28).

Potential on-site releases to the ground surface are expected to travel quickly to Joachim Creek and the Mississippi River. Erosion and dissolution of potential waste during rain and flooding events may allow for the direct transport and dissemination of contamination from the site to surface water or sediments. Precipitation could also result in leachate generation. The slag pile is not currently protected by cover material (Reference 26).

Joachim Creek, just below the northwest corner of the slag pile is considered the potential primary point of entry (PPE). All surface run-off from the slag pile reaches Joachim Creek at this PPE or at some other PPE downstream of this uppermost PPE. The Mississippi River and Joachim Creek are perennial, gaining streams; water is always present within their channels. The uppermost PPE is approximately 1.5 miles upstream of the confluence of Joachim Creek with the Mississipi River. The 15-mile downstream limit ends in Ste. Genevieve County on the Danby Quadrangle, in Section 3, T39N, R7E, near mile 139 of the Mississippi River (Reference 26).

According to the Flood Insurance Rate Map, the entire slag pile is located in a special flood hazard area inundated by the 100-year flood with a base flood elevation of 412 feet. A elevation reference mark was chiseled on the south rim of a manhole cover at the top of the slag pile near the end of a railroad track at the edge of a trail, about 300 feet south of the curve in Dale Street, 75 feet northeast of the old embankment at the left high bank of Joachim Creek. The elevation marked was 401.4 feet (Reference 29).

Floodwaters have reached the slag pile as recently as March 1998. Aerial and ground view photographs of the slag pile taken by U.S. Fish and Wildlife Services personnel in March 1998 document flood waters of Joachim Creek in contact with slag material. (Photos 1 - 7 in Appendix B) (Reference 19). The majority of the flooding of Joachim Creek in these photos reaches the slag pile from the east side. Doe Run officials report that during the major flood of 1993, waters reached several feet up the sides of the slag pile (Reference 5).

5.2 Surface Water Targets

There are no known drinking water intakes along Joachim Creek or the Mississippi River within 15 miles downstream of the site (Reference 30).

Joachim Creek is designated by the State of Missouri for the following uses: livestock and wildlife watering, protection of warm water aquatic life and human health-fish consumption, whole body contact recreation, boating and canoeing, and industrial (Reference 31, p. 72). Joachim Creek is used as a fishery. Doe Run officials report they often have to discourage people from fishing off of the old concrete railroad track bridge foundation on Joachim Creek near the northwest corner of the slag pile (Reference 5).

The portion of the Mississippi River near the site is designated for the following uses: irrigation, livestock and wildlife watering, protection of warm water aquatic life and human health-fish consumption, boating and canoeing, drinking water supply and industrial (Reference 31, p. 85). In 1997, an estimated 126 pounds of commercial fish were harvested along the Jefferson County portion of the Mississippi River; 3,550 pounds of fish were harvested along the Mississippi River in Ste. Genevieve County (Reference 32, Figure 1).

The Mississippi River is habitat for the federally-listed endangered pallid sturgeon (*Scaphirhynchus albus*), the threatened Bald Eagle (*Haliaeetus leucocephalus*), endangered Interior Least Tern (*Sterna antillarum athalassos*), and endangered Piping Plover (*Charadrius melodius*). The federally listed endangered Indiana bat (*Myotis sodalis*) might also occur (Reference 33).

According to the National Wetlands Inventory maps, a large portion of the slag storage area is designated as a wetland. In addition, numerous wetlands are located along the banks of Joachim Creek and the Mississippi River (Reference 34).

5.3 U.S. Fish and Wildlife Service Report: Preliminary Screening Level Ecological Risk Assessment for Fish and Wildlife Habitats around the Doe Run Company Lead Smelter (Reference 19)

In March 1999, DNR received a Draft Preliminary Screening Level Ecological Risk Assessment report for habitats around the Doe Run Lead Smelter in Herculaneum. The Assessment was conducted by U.S. Fish and Wildlife Service (USFWS), Region 3, Rock Island, Illinois. Over the past several years, USFWS personnel have monitored habitat quality along the Mississippi River as part of their trustee responsibilities. The results of these monitoring activities indicated that very elevated concentrations of heavy metal pollutants were observed in the Middle Mississippi River and in Joachim Creek around the confluence of these two waterways.

The area around the confluence of the Middle Mississippi River and Joachim Creek contains open water, seasonal wetlands and bottomland hardwood forest tracts. The river and creek bottomlands are flooded a few to several times per year related to snow melt and seasonal storms. These habitats support a variety of fish and wildlife including species under the trusteeship of the USFWS. Trust species include migratory birds and endangered species. A wide variety of migratory birds use these habitats during the breeding season and during migration times. There are migratory birds that use the site throughout much of the year such as red-tailed hawk, belted kingfisher and great blue herons. The Federally listed threatened bald eagle was observed using the site. The site contains suitable habitat and is within the range of the federally listed endangered fish species the pallid sturgeon.

Herculaneum Lead Smelter
Preliminary Assessment
March 30, 1998

As part of the investigation several soil, surface water and sediment samples were collected from in and around Joachim Creek and the Mississippi River. The results are detailed below.

River Floodplain Soils: Six Joachim Creek floodplain substrate samples adjacent to the slag piles were collected in March 1998 during a joint USEPA and USFWS field investigation. The data range was 109 to 26,900 ppm lead. Cadmium was detected as high as 115 ppm cadmium, and zinc up to 99,900 ppm.

River Channel Sediments: About sixteen aquatic sediment samples were collected between 1989 and 1995 at various locations downstream of the smelter facility in the main channels and channel borders for the Mississippi River and Joachim Creek. The data range was from normal up to 7,720 ppm lead on a dry weight basis. An average background lead concentration for aquatic sediments in Illinois streams is <60 ppm lead on a dry weight basis. The highest concentration of zinc detected was 29,400 ppm.

Surface Water: About eleven surface water samples were collected between January and March 1998 from flowing floodplain ditches and floodwater pools in Joachim Creek floodplain. The samples were collected during a joint USEPA and USFWS field investigation. The data range was 10.4 to 13,300 ppb lead. Zinc was detected as high as 310,000 ppb.

Fish, mammal and bird samples from species near the smelter were also collected. Fish tissue samples from locations downstream of the smelter contained lead from 0.414 to 7.476 ppm lead, while fish tissue from samples from reference area without an apparent significant source of lead contamination had a range of lead from non-detect up to 0.297 ppm. Three whole white-footed mouse samples were collected from locations along the shoreline of Joachim Creek adjacent to the smelter. The data range was 2.6 to 55 ppm lead. The livers of 21 "song birds" were collected at locations along the shoreline of Joachim Creek adjacent to the smelter. Five out of the 21 birds had liver lead values elevated above the threshold diagnostic of clinical lead poisoning (6 ppm). Clinical poisoning is defined by impaired biological functions and can be life threatening. Eight of the remaining 16 birds had liver lead values elevated above the threshold diagnostic of subclinical lead poisoning (2 ppm). Subclinical lead poisoning is defined by having physiological effects.

A toxicity test was performed with a sample of the slag material. A standard laboratory 96 hour elutriate bioassay test was conducted to evaluate the toxicity of the slag material to aquatic life. The test organism was the larval fathead minnow. At 24 hours 10 of the 20 organisms died. By 96 hours 18 of the 20 organisms died.

The potential contaminant problems identified by the USFWS investigation are numerous. Contaminants including arsenic, cadmium, copper, lead, nickel and zinc may be present in floodplain soil, river sediments and surface waters at concentrations that are toxic to desirable plants, invertebrates and fish that come in direct contact with the polluted media. Contaminants in the various media may also transfer through the food chain and pose risks to animals. Moderately contaminated soil may produce earthworms and support plants that are not killed by direct exposure. The earthworms may accumulate the contaminants in their body and plants may accumulate contaminants in the leaves and fruit. Animals such as the shrew, robin and woodcock that eat the worms may be at risk. Herbivores such as the white-footed mouse and cottontail rabbit that eat the plants may be at risk.

Fish from the river or creek may be contaminated and at risk from direct exposure to pollutants in the water or river sediments. Mink and fish-eating birds such as the kingfisher, greatblue heron and bald eagle that feed on these fish can be exposed to levels of contaminants that may affect their health. There may be health risks to predators such as the red-tailed hawk that eat the contaminated prey items (mice and rabbits). Highly contaminated dust and soil particles may also cover food items for wildlife and contribute to the risk. The availability of site soil, sediment and water contaminants to bioaccumulate in fish, mice and bird tissues is confirmed by chemistry tests completed as part of the investigation.

The purpose of the screening level ecological risk assessment is to quickly and conservatively characterize risk. Risk models and formulas are used to calculate risk hazard quotients. According to the USFWS report, the hazard quotients calculated for lead contamination indicate an increased ecological risk for several pathways predicted at the fish and wildlife habitats around the Doe Run Herculaneum Lead Smelter site.

5.4 Surface Water Conclusions

Data collected by USFWS as part of their preliminary ecological risk assessment indicates there has been a release of contaminants from the slag pile area into Joachim Creek and the Mississippi River. The findings of increased potential risk and harm to fish and wildlife near the site are significant.

Doe Run's releases into the Mississippi River are currently permitted under the Clean Water Act through an NPDES permit issued and monitored by the DNR's WPCP. Violations of the NPDES permit have been documented several times in the past by EPA and DNR inspectors. In the early 1970's excessive concentrations of lead, zinc, cadmium and copper were documented (Reference 35). The violations were not always associated with the wastewater treatment plant or its effluent. In 1993 and 1994 the violations were a result of a malfunction of a building sump pit. Lead, zinc, cadmium and arsenic limits set in the permit were all exceeded at in 1993 and/or 1994 (Reference 36).

The USFWS information should be thoroughly evaluated in relation to Doe Run's current application for an NPDES permit for storm water discharge from the slag pile area to Joachim Creek.

6.0 SOIL EXPOSURE AND AIR PATHWAYS

6.1 Physical Conditions

A Jefferson County soils report has not been completed, and, therefore, no specific soils information is available for the site area. The Ste. Genevieve County Soils report covers areas similar to the site setting, along the Mississippi River, approximately 14 miles downstream. Native soils at the slag pile are likely similar to the Haymond-Ross-Ashton association of Ste. Genevieve County. This association is developed on floodplains and terraces along tributaries of the Mississippi River. The soils are deep, nearly level, and well drained. The topsoils and subsoils may have moderate to high permeability (Reference 26).

The 28 acre (approximate) portion of property the smelter facility is situated on is near completely paved with buildings and tanks covering the ground surface. Railroad tracks border the eastern side of the facility between the buildings and the Mississippi River. Approximately 24 acres of the permitted 62 acres slag storage area is covered with slag. The ground surface surrounding the toe of the slag pile up to the Joachim Creek is floodplain soil with grassy vegetation, trees and shrubs (Reference 5).

The smelter facility is fenced with gates and signs. The entrance drive to the slag storage pile, off of Dale Street, is blocked with a locked cable (Reference 5).

6.2 Soil and Air Targets

The Herculaneum Smelter is situated along Main Street on the bank of the Mississippi River and is surrounded by the residences of Herculaneum. Several homes along Main Street are within 200 feet of the smelter facility, and at least four homes would be within 200 feet of the slag storage pile. Herculaneum High School, 564 enrollment, is located within 1/2 mile of the site. Herculaneum Elementary, 216 enrollment, is located within one mile of the site. The Senn-Thomas Middle School, 369 enrollment, is also located within one mile of the site (References 3; 5; 37).

The City of Herculaneum has an estimated population of 2,255 people (Reference 38, p. 148). Table 4 on the following page presents the breakdown of the number of people estimated to be within a four-mile radius of the site (Reference 39).

TABLE 4: ESTIMATED POPULATION WITHIN A 4-MILE RADIUS		
DISTANCE FROM SITE	ESTIMATED POPULATION	
	Missouri	Illinois
0 – 1/4	67	Not applicable
1/4 - 1/2	369	Not applicable
1/2 - 1	2,044	0
1 - 2	5,487	0
2 - 3	10,524	188
3 - 4	2,368	41
TOTAL	21,088	

6.3 Soil Sampling, Removal and Replacement (References 10; 40)

The lead smelter at Herculaneum has been operating since 1892. During the past 100 years, lead has been released from the smelter and contributed to elevated lead levels in the soil near the smelter. Various soil sampling projects conducted by Doe Run, Doe Run contractors, and the Missouri Department of Health have shown lead levels in surface soils of homes surrounding the smelter as high as 12,800 ppm. Natural background levels of lead in agricultural soils in this area (outside the influence of the smelter) would be expected to be in the range of 25 ppm to 40 ppm (Reference 41, p. H29).

In a 1992 study of blood lead levels of children in the Herculaneum area, out of 13 homes where the blood lead levels of children were greater than 15 ug/dl, 2 of those homes had lead levels in the surface soil surrounding the home at greater than 3,000 ppm. Three of them had levels ranging from 2000 - 2999 ppm lead. Seven of them had levels ranging from 1000 - 1999 ppm lead, and one had lead below 999 ppm. There have been several soils sampling events in which surface soil from homes has been analyzed for lead. Table 5 on page 26 a breakdown of the soil lead levels measured from a 1992 MDOH study, and various samples collected by Doe Run as part of their soil removal program.

In 1991, Doe Run voluntarily began a soil removal pilot program in which lead contaminated soil from properties near the smelter, including residential homes, lots and city property, were excavated and replaced with new soil. The pilot project began on August 19, 1991 with initial soil excavation on Doe Run property at 738 Circle Street. The project encompassed six residences, one vacant lot and a field area.

Each year since 1991, Doe Run has continued the soil removal program, averaging approximately 10-12 lots each year. The lots are chosen by Doe Run, and are usually in groups along one portion of a street or block. According to Doe Run officials, the plan was to start closest to the smelter and work their way out each year. The following paragraph details the process.

The yards are stripped of soil to a depth of 12 inches and small bushes and flowers are removed. The excavated contaminated soil is transported by trucks for storage at the smelter. The excavated soil is analyzed by Doe Run; if the contaminated soil contains lead at a level above the regulatory TCLP lead concentration of 5 ppm, it is processed through the smelter as a substitute for feed stock (sand). If the soil is below the TCLP regulatory limit, it is deposited in the slag storage area. Clean soil used for replacement is obtained from different sources. In 1991, clean soil was obtained from the agricultural Sandy Creek area, located approximately six miles from the smelter. Lead concentrations of the soil from Sandy Creek were 43 ppm and 53 ppm. Once the new soil is in place, the yards are sodded and bushes and flowers replaced. An average of three to four days is required to complete each yard.

In 1992, the soil removal project included six houses, two lots and city property. Clean soil for 1992 and 1993 was obtained from behind the Twin City Landscaping building location and from the Three Rivers Diving Company of Herculaneum. Three Rivers is located approximately two miles from the smelter. Analytical results from soil samples of the Twin City soil showed lead at 43 ppm. Analytical results from soil samples of the Three Rivers soil showed lead at 68 ppm. Clean soil for the 1994 project was again obtained from the Twin City Landscaping (lead at 15.4 ppm, 48.6 ppm and 63.6 ppm).

From 1991 to 1998 a total of approximately 84 lots, most of them residential were completed in the soil removal program. The 1999 soil replacement project is scheduled for approximately 30 residential lots.

In relation to the soil removal program, Doe Run also has a property purchase program. For several years, Doe Run has been purchasing pieces of property, including residences, near the smelter. Doe Run now owns approximately 85 lots (not including smelter property), including residences and vacant property in the Herculaneum area. Doe Run owns nearly all the residential lots on Main Street across from the smelter. They own several lots on School Street, Broad Street, Curved Street and Circle Court. Some of these properties are rented to residents, while others are vacant lots. Doe Run officials reported that the rental properties near the smelter are reserved for residents without young children, in an effort to reduce exposure to children under six, who are most at risk from harmful effects of lead poisoning (References 5; 40).

TABLE 5: LEAD LEVELS IN RESIDENTIAL YARDS SURROUNDING THE HERCULANEUM LEAD SMELTER								
Soil Sampling Data from Doe Run (Reference 40)								
Distance From Site (Stack) miles	**Lead Levels in ppm**							
0 - 1/4	26	1002	1328	2000	2437	3351	4007	8752
	190	1082	1400	2008	2704	3421	4030	8814
Average	328	1160	1420	2053	2753	3462	4170	8870
Concentration	482	1180	1420	2076	2900	3580	4202	9000
3014	515	1180	1469	2170	2902	3590	4344	10150
	518	1244	1520	2190	2908	3600	4488	18000
	530	1250	1597	2246	3002	3600	4720	
	640	1260	1688	2316	3059	3654	5220	
	712	1286	1817	2375	3072	3658	5300	
	802	1302	1820	2390	3090	3790	5322	
	895	1315	1825	2408	3280	3820	7470	
	957	1320	1920	2426	3320	3843	8571	
1/4 - 1/2	367	718	1000	1160	1492	1740	2010	3669
	390	806	1033	1167	1560	1800	2100	3715
Average	438	808	1050	1210	1560	1810	2200	3802
Concentration	500	810	1070	1248	1594	1858	2505	4674
1791	567	870	1120	1330	1600	1898	2527	5952
	600	870	1120	1340	1618	1940	2564	7940
	614	886	1130	1349	1669	1970	2615	8507
	629	912	1132	1400	1700	1998	3147	
	690	945	1132	1400	1717	2000	3180	
	698	963	1138	1440	1718	2000	3515	
1/2 - 1 mile	13	400	525	715	1170	2310		
Average	300	487	588	735	1190			
Concentration								
767								

6.4 Soil Exposure Pathway Conclusions

As would be expected after over 100 years of smelting lead in Herculaneum, soil sampling conducted in several studies since 1984 has shown significantly elevated levels of lead in the residences surrounding the smelter. Historic air emissions from the smelter, before technology was significantly improved, most likely contributed to the majority of the contamination.

According to estimations on a Herculaneum map and information provided by Doe Run, approximately 54 residential yards out of a total 153 located within 1/4 mile of the smelter have been through the soil removal program as of 1998. In 1999, an additional 26 residences within 1/4 mile are scheduled to be in the program. Within 1/2 mile of the smelter, 15 of the 187 residences have been through the program. These calculations do not include what appeared to be vacant lots.

There are several screening levels for lead. EPA has recommended 400 ppm as a residential screening level. The MO ASL is 240 ppm. SCDM does not have any soil screening levels for lead. Removal actions at the Oronogo-Duenweg Mining Belt site (MOD980686281), more commonly referred to as the Jasper County Mining Site, can be used for further comparison. Currently in Jasper County, 800 ppm lead is the action level for excavation of soil in residential yards that were contaminated due to smelter fallout. In lieu of excavation, remedial action and institutional controls are required at residences with contamination between 500 ppm and 800 ppm lead. These actions include health education and providing HEPA vacuums to the residents, as well institutional controls related to sale of property (yet to be determined). The time critical removal action level is 2500 ppm. Any yards with a lead level of exceeding 2500 ppm are worked on immediately. Also, any homes where children have elevated blood lead levels (above 15 ug/dl) and soil lead levels above 500 ppm, are addressed as time critical. There have been over 1400 yards completed so far in the soil removal action at that site.

7.0 AIR PATHWAY

7.1 General Information

On October 5, 1978, the EPA, under the authority of the Clean Air Act, proposed a federal air quality standard for lead. This standard is referred to as the National Ambient Air Quality Standard (NAAQS). The NAAQS for lead is 1.5 micrograms per cubic meter (ug/m^3) averaged over a calendar quarter. A State Implementation Plan, or SIP, is a plan prepared by state environmental agencies (DNR's Air Pollution Control Program (APCP), with input from EPA, that outlines how a company or community plans to reduce air pollution emissions to bring the area into compliance with the NAAQS. The plan serves as a blueprint for how the NAAQS will be achieved. A SIP might include installing specific equipment, making process changes, or adding employee training. Computer models are often used in designing SIPs to detemine what measures will enable a company to achieve the air quality goals. The SIPs are mandated by law and monitored by the state agencies. Most SIPs in Missouri are written for a community and consider the impact of emissions from many facilities, but Doe Run Herculaneum Smelter site has its own SIP because it is the predominant source of lead emissions in the area (References 9; 42).

When a company agrees on an environmental course of action by negotiating a SIP with regulators, it promises to take the steps outlined in the document. Both sides agree to the measures because it is determined by EPA computer models that the SIP will enable a company to achieve the ambient air quality goals. If a company follows the steps agreed upon in the SIP, it is determined to be in compliance with the plan. However, a company can be in compliance with a SIP even if air quality goals are not achieved. There are two goals of the process: first to take the actions described in the

SIP, the second to stay within the mandated air levels. If a plan is insufficient and the air quality goals are not achieved, a new SIP is mandated (References 9; 42).

The first Doe Run Herculaneum SIP was implemented in 1980, and revised in 1984, 1990, and 1993. Doe Run has complied with each of the SIP revisions, but because NAAQS have not been met, development of a new SIP began in 1998. Once complete, the new SIP will outline additional measures to be taken to meet the NAAQS. Some of those additional measures may include: improved material handling systems, building or process enclosure and ventilation, improved ventilation hoods, better plant housekeeping practices, and additional emission control systems (References 9; 42).

The 350-foot brick stack that served the Herculaneum smelter since 1910 was replaced in 1997 with a 550-foot concrete model. Doe Run reports that the new stack handles a greater volume of air allowing for more effective emission controls today and added ventilation capacity in the future (Reference 43).

7.2 Air Monitoring

There are currently eight high volume air monitoring stations set up in the vicinity of the Herculaneum Lead Smelter to track the amount of lead being emitted. Figure 4 shows the location of all the monitors on a topographic map of the area. Most of the monitors operate for 24 hours every 6th day to gather data on a quarterly basis. Table 6 on page 30 presents the lead ambient air quality data as measured by these air monitoring stations. The table includes data from 1994 to the present. Reference 44 includes data as far back as 1982 (References 44; 9).

Six of the air monitoring stations have been in place for 20 years. These six stations have met the NAAQS for eight consecutive quarters during 1997 and 1998. The seventh station was added in 1992 at Broad Street across the street from the smelter. It has not attained the standard for any quarter since it was installed and even recently very high concentrations have been monitored (Reference 12).

As a result of this tread, Doe Run will be installing Teflon bags at the largest sinter plant baghouse by July of 1999 to more efficiently capture lead dust. The other baghouses already have been fitted with similar bags. Additionally, Doe Run will attempt to determine the impact of various smelter operations on emission levels at the site's fenceline. Once that work is complete, appropriate new controls may be put in place (Reference 12).

Air monitoring is also conducted to track the amount of sulfur dioxide emissions. The levels of sulfur dioxide emissions as measured by the stations is within federal standards (Reference 12). Despite this, DNR has received several complaints from nearby residents claiming they can smell the sulfur in the air occasionally, and that acid seems to be destroying the paint on their cars (Reference 45). It is possible that the sulfur dioxide standards are being exceeded in some locations under some meteorological conditions, but these episodes have not been verified by air monitoring (Reference 42).

7.3 Air Pathway Conclusions

DNR's APCP is currently negotiating a new SIP with Doe Run under authority of the Clean Air Act. APCP reports that management of the air pathway at the Herculaneum Smelter site under the Clean Air Act is sufficient. Action under CERCLA is not warranted at this time.

It should be noted, however, that there is a potential for yards at homes in the soil removal project near the smelter to be recontaminated by lead fallout from smelter emissions. Bringing the area and the Broad Street monitor into compliance with the NAAQS as quickly as possible will reduce this potential for fallout.

TABLE 6: LEAD AMBIENT AIR QUALITY DATA – VICINITY OF HERCULANEUM LEAD SMELTER
CALENDAR QUARTERLY VALUES
In micrograms of lead per cubic meter of air ($\mu g/m^3$)
HI-VOL MONITOR LOCATIONS

Date	S[1] Dunklin	H[1] Dunklin	H Golf	H North	H Ursaline	H Bluff	H Sherman	H Broad St.
1994								
1st	.5	.4	.3	.2	.2	.8	.6	**3.5**
2nd	.6	.7	.3	.2	.1	**2.1**	.5	**3.7**
3rd	**1.8**	1.3	.1	.3	.1	.9	.6	**3.9**
4th	**2.1**	1.4	.2	.3	.1	1.1	.9	**3.1**
1995								
1st	.7	.6	.5	.2	.2	1.49	.8	**6.5**
2nd	1.0	.7	.1	.2	.1	1.0	.4	**2.5**
3rd	1.4	1.2	.3	.3	.2	1.0	1.2	**4.1**
4th	**1.9**	**1.7**	.4	.8	.1	**1.6**	1.3	**6.3**
1996								
1st	**2.3**	**1.9**	.3	.4	.1	1.4	.8	**2.3**
2nd	**1.6**	1.2	.5	.1	.2	**2.4**	.8	**5.7**
3rd	.8	.6	.1	.2	.3	.7	.5	**4.0**
4th	**1.7**	**1.8**	.1	.5	.3	1.4	.9	**1.6**
1997								
1st	.8	.7	.1	.1	.3	1.4	.5	**4**
2nd	1.4	1.3	.3	.2	.2	.5	.4	**6.8**
3rd	1.3	1.1	.1	.1	.2	.8	.5	**1.6**
4th	1.5	1.3	.5	.6	.1	1.3	.8	**8.5**
1998								
1st	1.3	1.1	.2	.2	.2	1.2	.4	**11.6**
2nd	1.5	1.4	.2	.3	.1	.6	.5	**4.1**
3rd	.9	.8	.1	.3	.1	1.1	.6	**3.9**

NOTES:
1 (S) = State Monitor, (H) = Herculaneum monitor
2 Underlined and Bolded Quarterly Air Quality Values exceed the (NAAQS) National Ambient Air Quality Standard for lead;

8.0 SUMMARY AND CONCLUSIONS

The Herculaneum Lead Smelter site is located at 881 Main Street in Herculaneum, Missouri. The site is located about 25 miles south of St. Louis, on the Mississippi River. The Herculaneum lead smelter, owned and operated by the Doe Run Company, is currently the largest lead smelter in the United States. The smelter has been in operation since 1892.

Herculaneum Lead Smelter
Preliminary Assessment
March 30, 1998

This site was formerly known as the St. Joe Lead Co. and is listed in the CERCLIS as the St. Joe Lead Co. site (MOD006266373). A Preliminary Assessment was completed by EPA Region VII on September 25, 1980, when the site was still known as St. Joe Lead Co. A Site Inspection was also conducted by EPA in September 1980. The recommendation in 1981, based on conclusions from the PA and SI at that time, was for no action under CERCLA based on the rationale that the slag material was not hazardous by law. Apparently, the slag material was being viewed as exempt under the "bevil exclusion". However, the bevil exclusion only applies under the Resource Conservation and Recovery Act, not under CERCLA. Current information regarding site conditions today indicated the site warrants a new Preliminary Assessment investigation. This Preliminary Assessment was initiated on July 15, 1998. Investigation included a site visit on February 25, 1999.

The site is approximately 52 acres in size, consisting of two main areas, the smelter plant located along the east side of Main Street from Station Street to Ferry Road (28 acres), and the slag storage pile located south-southwest of the plant in the floodplain of Joachim Creek (24 acres). The two main source areas of concern associated with the site are the slag pile and the soil in the surrounding town of Herculaneum that has been contaminated with smelter fallout.

<u>Groundwater Pathway</u>
According to a statistical analysis of groundwater monitoring data from the 14 monitoring wells in the slag pile area, zinc has been released from the slag pile into the shallow groundwater above background concentrations. The highest documented concentration of zinc was 484 ppb (August 31, 1992); background concentration was less than 6 ppb. None of the levels of the dissolved zinc in the groundwater exceeded human health screening or action levels.

<u>Surface Water Pathway</u>
Data collected by U.S. Fish and Wildlife Service as part a Preliminary Ecological Risk Assessment for Fish and Wildlife Habitats around the Doe Run Smelter, indicates there has been a release of heavy metal contaminants, including lead and zinc, from the slag pile area into Joachim Creek and the Mississippi River. Surface water and sediment samples from Joachim Creek showed elevated levels of lead and zinc above background. Tissue samples collected from fish, birds and mammals near the site also show elevated levels of lead. Most significantly, 5 out of 21 birds tested had liver lead values elevated above the threshold diagnostic of clinical lead poisoning. The USFWS report documents an increased potential risk of harm to fish and wildlife near the site.

Doe Run's releases into the Mississippi River are currently permitted under the Clean Water Act through an NPDES permit issued and monitored by the DNR's WPCP. Doe Run also has an application pending with WPCP for an NPDES permit for storm water discharge from the slag pile area to Joachim Creek.

Soil Exposure Pathway

Air emissions, or "smelter fallout", from over 100 years of smelting lead in Herculaneum, has contributed to significantly elevated lead levels in the soil of property within at least one mile of the smelter. Soil sampling conducted in several studies since 1984 has shown the soil of residences located within ¼ mile of the smelter contains lead at an average level of approximately 3,014 ppm; within ½ mile of the smelter the average lead level is approximately 1,791 ppm. The EPA has recommended 400 ppm as a residential screening level for lead in soil. The Missouri Department of Health's published any-use soil level for lead is 240 ppm. For further comparison, at an NPL site in Jasper County, MO where residential yards were contaminated with lead from a smelter, the removal action levels range from 500 ppm to 800 ppm, with a time critical actions for yards exceeding 2500 ppm.

Since 1991, Doe Run has voluntarily been conducting a soil removal program for the citizens of Herculaneum. Lead contaminated soil from properties near the smelter, including residential homes, lots and city property, have been excavated and replaced with new soil. According to estimations on a Herculaneum map and information provided by Doe Run, approximately 54 residential yards out of a total 153 located within 1/4 mile of the smelter have been through the soil removal program as of 1998. In 1999, an additional 26 residential yards within 1/4 mile are scheduled to be excavated and replaced with clean soil. Within 1/2 mile of the smelter, 15 of the 187 residences have been through the program.

Air Pathway

Under authority of the Clean Air Act, DNR's Air Pollution Control Program (APCP) is currently negotiating a new State Implementation Plan with Doe Run in order to attempt to bring the facility into compliance with National Ambient Air Quality Standards. Out of a total of eight air monitoring stations surrounding the smelter, one station closest to the facility, has not achieved the NAAQS goal for lead (1.5 ug/m^3). APCP reports that management of the air pathway at the Herculaneum Smelter site under the Clean Air Act is sufficient. Action under CERCLA for the air pathway is not warranted at this time.

9.0 RECOMMENDATIONS

This site qualifies for further action under CERCLA. The extent of contamination of the residential properties surrounding the smelter facility should be further defined, as well as the extent of releases from the contaminants in the slag pile to Joachim Creek. The findings of USFWS preliminary ecological risk assessment indicate the potential for significant harm to fish and wildlife surrounding the site. An Expanded Site Inspection is recommended.

Herculaneum Lead Smelter
Preliminary Assessment
March 30, 1998

Prepared by: Valerie H. Wilder

Valerie H. Wilder
Environmental Specialist
Site Evaluation Unit

Reviewed by: Julieann Warren

Julieann Warren
Chief
Site Evaluation Unit

Approved by:

Gary T. Behrns
Chief
Superfund Section

REFERENCES

1. U.S. Environmental Protection Agency Hazard Ranking System, 40 CFR Part 300, Appendix A, 55 FR 51583, December 14, 1990.

2. U.S. Environmental Protection Agency, September, 1995, Superfund Chemical Data Matrix.

3. U.S. Geological Survey. Topographic Maps. 7.5-Minute Series. Festus, MO. 1964, photorevised 1982. Herculaneum, MO. 1954, photoinspected 1979, photorevised 1968 and 1974. Selma, MO.-ILL. 1964, photorevised 1982. Valmeyer, IL-MO, 1993.

4. Missouri Department of Natural Resources, DEQ, Appendix A. Locational Data Collection Sheet. February 25, 1999. 1 page.

5. Wilder, Valerie H., Environmental Specialist, HWP, DEQ, DNR to Herculaneum Lead Smelter Site File. Memo. Site Visit to the Herculaneum Lead Smelter Site. February 26, 1999. 3 pages.

6. Internet Information: "Midwestern Climate Center." <http://mcc.sws.uiuc.edu>

7. Division of Geology and Land Survey. Missouri Department of Natural Resources. Missouri Water Atlas. 1986. 97 pages.

8. U.S. Department of Agriculture. Soil Survey of St. Louis County and St. Louis City, Missouri. April 1982. 4 Pages.

9. The Doe Run Company Internet Hompage. http://doerun.com/. March 11, 1999. 10 pages.

10. The Doe Run Company 1991 Environmental Progress Report. February 4, 1992. 18 pages.

11. Environmental Services Division, U.S. Environmental Protection Agency, Region VII. Report of RCRA Compliance Inspection at the Doe Run Company - Herculaneum Smelter Herculaneum, MO, EPA I.D. Number: MOD006266373 on January 31 - February 2, 1995. 11 pages.

12. The Doe Run Company Report to Our Community 1998 Herculaneum, Missouri. 8 pages.

13. Environmental Services Division, U.S. Environmental Protection Agency, Region VII. Report of the Compliance Sampling Inspection of the Doe Run Company Smelting Division, Herculaneum, Missouri, January 31 - February 1, 1995. 8 pages.

14. Missouri Clean Water Commission. Department of Natural Resources. Missouri State Operating Permit. Permit No. MO-0000281. June 9, 1995. 8 pages.

15. Lanzafame, James M., Environmental Manager, Doe Run Company to David Green, HWP, DEQ, DNR. Second Quarter 1998. 5 pages.

16. United States Environmental Protection Agency, Region VII. Toxic Release Inventory Reporting Requirements. http://www.epa.gov/rgytgrnj/programs/artd/toxics/triwhat.html. 1 page.

17. TRI Trend Analysis for Doe Run Co., Herculaneum. Run March 25, 1999. 5 pages.

18. TRI Data Analysis Report for 1988 - 1996, Top Emitters. Run March 25, 1999. 9 pages.

19. Shope, Thomas D., Attorney Advisor, Office of the Solicitor, United States Department of the Interior to Valerie H. Wilder, Environmental Specialist, Hazardous Waste Program, DEQ, DNR. Letter. Draft Preliminary Screening level Ecological Risk Assessment for Fish and Wildlife Habitats Around the Doe Run Smelter, Herculaneu, Missouri. March 11, 1999. 1 page plus attachment.

20. U.S. Department of Health & Human Services. Public Health Service. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Cadmium. Draft for Public Comment (Update). September 1997. 347 pages plus Appendices.

21. Sittig, Marshall. Handbook of Toxic and Hazardous Chemicals and Carcinogens. Second Edition. 1985. 950 pages.

22. U.S. Department of Health & Human Services. Public Health Service. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Lead. Draft for Public Comment (Update). August 1997. 483 pages plus Appendices.

23. U.S. Department of Health & Human Services. Public Health Service. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Zinc. Update. May 1994. 230 pages plus Appendices.

24. Mehan, G. Tracy, III, Director, Missouri Department of Naturals Resources to Mr. Gary Boyer, Vice President Smelting and General Manager, Doe Run Company. Letter. Metallic Minerals Waste Management Permit Number MM-001 for the Doe Run Herculaneum Smelter. January 21, 1992. 1 page with Attachments.

25. Lanzafame, James M. Environmental Manager, Doe Run Company to Mr. Charles Stiefermann, P.E., Staff Director, Land Reclamation Program, DNR. MM-001 Permit Modification Request. December 19, 1995. 1 page

26. Elfrink, Neil, Geologist, Environmental Geology Section, GSP, DGLS to Valerie Wilder, Environmental Specialist, Superfund Section, HWP, DEQ. Memo. Hydrogeologic Report for the Herculaneum Smelter Site. October 30, 1998. 10 pages plus references.

27. Maxim Technologies, Inc. Final Herculaneum Slag Storage Area Groundwater Monitoring Program, September 1987 through January 1998. Prepared for: The Doe Run Company. July 1998. 9 pages plus Tables and Figures.

28. Doe Run Herculaneum Smelter. Information Sheet. July 22, 1998.

29. Federal Emergency Management Agency, National Flood Insurance Program. Flood Insurance Rate Map, City of Herculaneum, Missouri, Jefferson County. Community-Panel Number: 290192 0005 D. Map Revised: November 17, 1993.

30. Missouri Department of Natural Resources, Division of Environmental Quality. Inventory of Missouri Public Water Systems. 1999. 211 pages.

31. Code of State Regulations, Rules of Department of Natural Resources, Division 20-Clean Water Commission, Chapter 7-Water Quality. Water Quality Standards, 10 CSR 20-7.031, March 30, 1994. 114 Pages.

32. Robinson John W., Missouri Department of Conservation. Missouri Commercial Fish Harvest 1997. November 1998. 11 pages.

33. Wilson, R. Mark, Field Supervisor, U.S. Fish & Wildlife Service to Julie B. Kelsey, HWP, DEQ, DNR. Letter. December 18, 1998. 4 pages.

34. United States Department of the Interior, Fish and Wildlife Service. National Wetlands Inventory Maps. Herculaneum, MO, 1993 - Aerial Photography march 1985. Selma, MO-ILL, 1988 - Aerial Photography April 1984.Valmeyer, ILL-MO, 1988 - Aerial Photography April 1984.

35. Bates, Dale I., Environmental Scientist, FINV/ENSV, EPA to Robert B. Dona, Chief, Water Section, FINV/ENSV, EPA. Memo. St. Joe Lead Company, Herculaneum, Missouri. September 28, 1982. 1 page plus attachment.

36. Huck, James W., P.E., Environmental Engineer, DNR to Mr. John E. FitzSimmons, Vice President and General Manager, Doe Run Company. Letters. Abbreviated Inspection of Doe Run Company's Herculaneum Smelter Wastewater Treatment Plant. May 12, 1993 and May 26, 1994.

37. 1998-99 Missouri School Directory - As of October 1998. Missouri School District Directory: Dunklin R-V. http://www/dese.state.mo.us/directory/050005.html. 2 pages.

38. U.S. Department of Commerce. 1990 Census of Population and Housing. Summary Population and Housing Characteristics. August 1991. 2 Pages.

39. Marble/Geocorr Geographic Correspondence Engine. Version 3.01. Census Count Information. Internet address: http://www.oseda.missouri.edu/plue/geocorr/. 12 pages.

40. Lanzafame, James M., Environmental Manager, Doe Run Company, Smelting Division to Ms. Valerie Wilder, HWP, DNR. January 25, 1999. 2 pages plus Enclosures.

41. Tidball, Ronald R. Geochemical Survey of Missouri - Geography of Soil Geochemistry of Missouri Agricultural Soils. Geological Survey Professional Paper 954-H, I. United States Government Printing Office, Washington. 1984.

42. Rustige, John, Air Pollution Control Program, DEQ, DNR to Valerie Wilder. Electronic Mail Memo. Comments on Air Information. March 30, 1999. 1 pages plus attachment.

43. The Doe Run Company Report to Our Community 1997 Herculaneum, Missouri. 12 pages.

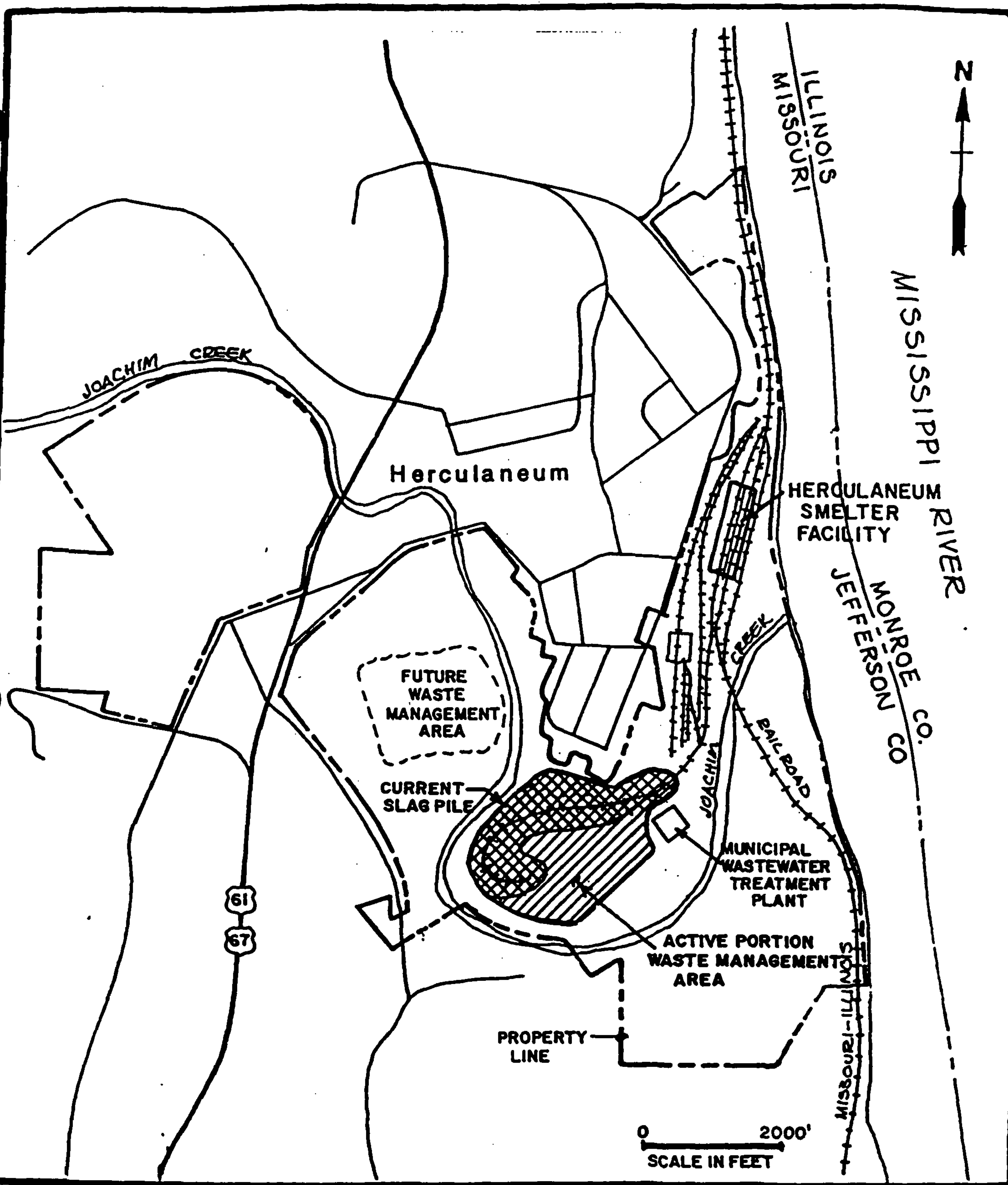
44. EPA Aerometric Information Retrieval System, Air Quality Subsystem, Quick Look Report. Lead Ambient Air Quality Data - Vicinity of Herculaneum Lead Smelter. April 4, 1998.

45. Missouri Department of Natural Resources, Division of Environmental Quality. Complaint Investigation Information Sheets. 4 pages.

APPENDIX A
FIGURES

Figure 1: Site Location Map
Herculaneum Lead Smelter
Jefferson County, Missouri

FIGURE 2



ENVIRODYNE ENGINEERS

FIGURE 2

Project Location Map
The DOE RUN COMPANY
Herculaneum Smelter Facility

Summary of MDNR Preliminary Assessment, Dated March 30, 1999

I. Previous Investigations:

1. EPA lead PA completed in Sept. 1980
2. EPA Lead SI completed in Sept. 1980
3. Feb. 1981 Final Strategy Determination of no action needed, based on non hazardous source material (slag) and steps being taken to correct water quality problems.
   (No samples were taken during the investigations)
4. U.S. Fish and Wildlife Study completed in March of 1999

II Current Status of Facility

1. Doe Run Herculaneum Smelter is classified as a Large Quantity Generator
2. Toxic Release Inventory reports have shown an 80% decrease in releases to the three media (air, water and land) since 1980.
3. Slag from the smelter are disposed of in Metallic Mineral Waste Management Area (WMA) that was permitted under the Metallic Mineral Waste Management Act of Missouri (April 29, 1991). The WMA permit states that there should be no Point Source discharge so there is no NPDES permit for the WMA. There is currently a NPDES permit application under review at DNR. The WMA operation permit states that the WMA is to remain in operation until 2031.
4. Analytical results of the slag pile show: total arsenic - 28 ppm, total cadmium - 32 ppm., total copper - 3,200 ppm, total lead - 23,000 ppm, total nickel - 140 ppm, and total zinc - 96,000 ppm.
5. Doe run is researching the alternative of fuming the slag to recover the zinc prior to closure.

III Groundwater Pathway:

3. According to analysis of groundwater monitoring data, zinc has shown a release into the shallow groundwater aquifer (484 ppb) above background levels (6 ppb). None of the measured levels are above EPA Removal Action Levels for drinking water (3,000 ppb) or SCDM Dose concentrations (11,000 ppb) There is no EPA MCL for zinc.
4. Due to the groundwater gradients below the site and the recharge zone of the adjacent Joachim Creek and the Mississippi River groundwater is not expected to recharge to the bedrock aquifer.

IV Surface Water Pathway

1. Surface water from north of the slag pile has recently been diverted to a diversion

creek which flow to Joachim Creek and eventually the Mississippi. Precipitation that falls on the slag pile also eventually reaches the Joachim Creek. Doe Run submitted an application to DNR in July 1998 for a storm water permit to discharge from the slag pile into Joachim Creek. The slag pile is located in the 100 year flood plain. Flood waters reached the slog pile in March of 1998.

2. There are no water intakes within 15 miles downstream of the site.
3. Joachim Creek is designated for livestock watering protection of warm water aquatic life and human health fish consumption, body contact recreation, boating and industrial use as well as a fishery. In 1997 126 lbs of fish were commercially harvested along the Jefferson county portion of the Mississippi adjacent to the site and 3550 lbs of fish were harvested in St. Genevieve county portion of the Mississippi.
4. U.S. Fish and Wildlife Service Report: Preliminary Screening Level Ecological Risk Assessment for Fish and Wildlife Habitats around the Doe Run company Lead Smelter.
   a. Over the past several years USFWS have monitored habitat quality along the Mississippi River. The results indicate heavy metal pollutants in the Middle Mississippi River and in Joachim Creek around the confluence of these two waterway.
   b. Included in the area supported species are migratory birds and endangered species.
   c. Flood plain substrate sample results range from 109 to 26,900 ppm lead , 115 ppm cadmium and up to 99,900 ppm zinc.
   d. River Channel sediments ranged from normal to 7,720 ppm lead and up to 29,400 ppm zinc.
   e. Surface water from flowing flood plain ditches and pools in Joachim creek ranged from 10.4 to 13,300 ppb lead and zinc as high as 310,000 ppb.

V Soil Pathway

1. In 1992 a study of blood lead levels of children in the Herculaneum area showed surface soil lead levels greater than 3,000 ppm
2. In 1991 Doe Run voluntarily began soil excavation and replacement. This effort included six residences, one vacant lot and a field area. Since 1991 Doe Run has completed between 10 to twelve lots per year and has accomplished approximately 84 lots, mostly residential.
3. Doe Run has also continued a property purchase program and now owns approximately 85 lots. Several of these residences are rental property, however Doe Run maintains that the residences nearest the smelter are reserved for families without small children.

VI Air Pathway.

The Herculaneum Smelter currently operates under a State Implementation Plan (SIP) which has been modified numerous times due to air quality standards not being met. A new Sip is currently being negotiated with DNRs Air Pollution Control Program

VII Additional Superfund action is recommended by MDNR, in the form of a Expanded Site Inspection.

Conf Call 22ND.